Marconi
Instruments

6920

RF POWER SENSOR

MP MASTER
MA31162

Instruction Manual

Instruction Manual

H 6920

RF POWER SENSOR

6920

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PRELIMINARIES

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Contents
Notes and Cautions

CHAPTERS

1 General information
2 Installation
3 Operation
4 Technical description
5 Maintenance
6 Replaceable parts
7 Servicing diagrams

HAZARD WARNING SYMBOLS

The following symbols appear on the equipment.

Symbol	*Type of hazard*	*Reference in manual*
	Static sensitive component	Page (iii)
	RF input limitation	Chap. 1, page 2
	Precision connector	Page (iv)

Note...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus ▶ ..... ◀ to show the extent of the change. When a chapter is reissued the triangles do not appear.

Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2, etc.

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This accessory, when used with the 6950 or 6960 RF Power Meter, is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 148 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition.

MEASUREMENT PRECAUTIONS

This sensor contains an extremely sensitive detector. Because of this the r.f. connector must be properly terminated to prevent stray radiation being detected and displayed on the power meter. It is also important to allow thermal stability to be obtained before zeroing or operating the power meter.

CAUTION : STATIC SENSITIVE COMPONENTS

Components identified with the symbol on the circuit diagrams and/or parts lists are static sensitive devices. The presence of such devices is also indicated in the equipment by orange discs, flags or labels bearing the same symbol. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or fast surges.

(1) If a printed board containing static sensitive components (as indicated by a warning disc or flag) is removed, it must be temporarily stored in a conductive plastic bag.

(2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

(3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

WARNING : HANDLING HAZARDS

Whilst every endeavour has been made to remove sharp points and edges care should be taken, particularly when servicing the equipment, to avoid minor cuts.

WARNING : TOXIC HAZARD

Many of the electronic components used in this equipment employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.

⚠ *CAUTION : PRECISION CONNECTOR*

The precision type N connector fitted to this sensor may be damaged by mating with general purpose type N connectors.

Chapter 1

GENERAL INFORMATION

CONTENTS

Para.
1 Features
3 Performance data
4 Accessories

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1 RF Power Sensor type 6920 1

FEATURES

1. The RF Power Sensor 6920 is for use with analog RF Power Meter type 6950 and microprocessor RF Power Meter type 6960 to measure r.f. power from 10 MHz to 20 GHz over a 50 dB dynamic range from -70 dBm to -20 dBm.

2. Each sensor has an individual label showing calibration factor graph, linearity factor and reference calibration factor. The linearity factor is a power linearity correction figure that can be used to enhance power accuracy. The reference calibration factor is the calibration factor at 50 MHz with respect to the maximum calibration factor over the frequency range, this being designated 100%.

Fig. 1 RF Power Sensor type 6920

PERFORMANCE DATA

	Characteristic	*Performance*
3.	Power range :	-70 dBm (.1 nW) to -20 dBm (10 µW).
	Maximum r.f. input :	+26 dBm average, +30 dBm peak.
	Frequency range :	10 MHz to 18 GHz, usable to 20 GHz.
	VSWR :	10 MHz to 40 MHz : 1.4 to 1.2, 40 MHz to 10 GHz : 1.2, 10 GHz to 18 GHz : 1.35, 18 GHz to 20 GHz : 1.4 (typical).
	Linearity factor :	Provided with sensor.* Accuracy ±0.5%.
	Calibration factor :	Provided with sensor.
	RF connector :	Precision N-type male, 50 Ω.
	Output connector :	Multiway. Mates with sensor cable assembly (supplied with power meter).
	Size :	104 mm long (including connectors), 33.5 mm dia.
	Weight :	180 g.

* Linearity factor is preset in 6950 and selectable in 6960.

ACCESSORIES

Supplied accessories

		Code no.
4.	30 dB pad, for use in calibration. 30 dB ±.05 dB at 50 MHz.	6531-8
5.	Range scale for 6950. This attaches magnetically to the range control on the 6950.	6920-008

Chapter 2

INSTALLATION

UNPACKING AND REPACKING

1. Retain the packing materials and the packing instruction note (if included) in case it is necessary to reship the sensor.

2. If the sensor is to be returned for servicing attach a label indicating the service required, type number, serial number and your return address.

3. If the original container or materials are not available use a strong double-wall carton packed with shock absorbing material around all sides of the sensor to hold it firmly.

Chapter 3

OPERATION

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Para.
1 With Power Meter type 6950
6 With Power Meter type 6960
11 Low power measurements

With Power Meter type 6950

1. Connect the power sensor to the SENSOR INPUT socket using the sensor cable assembly supplied with the instrument. With no power applied to the sensor adjust the ZERO control on the most sensitive range (range switch fully anti-clockwise) for zero reading on the meter.* The rear panel RESPONSE-TIME potentiometer may be adjusted to reduce the noise, helping to set the zero. It may be easier to start on a less sensitive range as the ZERO adjustment has a large effect.

2. Connect the sensor, via the 30 dB pad, to the POWER REFERENCE output. With the magnetic range scale for 6920 in place, set the RANGE switch to -30 dBm. Set the CAL FACTOR to the REFERENCE CAL FACTOR figure indicated on the power sensor. Turn on the POWER REFERENCE on the rear panel and adjust the front panel GAIN control for a full scale meter reading.

3. Turn off the POWER REFERENCE and disconnect the sensor from the output.

**CAUTION*

Before setting up or making measurements allow time for thermal stabilization.

4. Determine the CAL FACTOR for the measurement frequency from the calibration curve on the power sensor or the calibration certificate provided. Set the CAL FACTOR accordingly.

5. The power meter can now be used for measuring r.f. power.* For full instructions and uncertainty calculations refer to the 6950 Operating Manual, Chapter 3.

With Power Meter type 6960

6. Connect the power sensor to the SENSOR INPUT socket using the sensor cable assembly supplied with the instrument. Determine the linearity factor of the sensor from the calibration label on the sensor or the calibration certificate provided. Enter this into the 6960 using the LINEARITY FACTOR function. Determine the REFERENCE CAL FACTOR from the sensor label or calibration certificate provided. Enter this into the 6960 using the CAL FACTOR facility.

7. Connect the 30 dB pad to the sensor.* With no power applied to the sensor press AUTO ZERO. When this routine is complete, connect the sensor, via the 30 dB pad, to the POWER REFERENCE of the 6960. Press AUTO CAL. The instrument will now read -30 dBm with the POWER REF turned on.

8. Turn off the POWER REF and disconnect the sensor from the POWER REFERENCE output.

9. Determine the CAL FACTOR for the measurement frequency from the calibration curve on the power sensor or the calibration certificate provided. Use the CAL FACTOR function to enter this on the 6960.

10. The power meter can now be used for measuring r.f. power.* For full instructions and uncertainty calculations refer to the 6960 Operating Manual, Chapter 3.

**CAUTION*

Before setting up or making measurements allow time for thermal stabilization.

Low level power measurements

11. The 6920 Power Sensor used with a 6930 or 6960 Power Meter is an extremely sensitive measuring system capable of reading power levels as low as 100 pW (-70 dBm). It is therefore necessary to follow a few simple precautions to ensure an accurate reading at these low levels.

(i) Allow the sensor to stabilize to ambient temperature before attempting to start the calibration and measurement.

(ii) Ensure the sensor is not subjected to changes of temperature during the calibration and measurement. For example, handle the sensor as little as possible and do not carry out the measurement in a stream of hot air from an instrument.

(iii) When zeroing the sensor ensure that it is not receiving radiated power at its input connector.

(iv) During the measurement the effect of noise can be reduced by either increasing the RESPONSE-TIME (rear panel control) on the 6950 or increasing the AVERAGING FACTOR on the 6960.

Chapter 4

TECHNICAL DESCRIPTION

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1 Overall circuit description
2 Detailed technical description
2 RF sensor
3 Signal chopper
5 Amplifier

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1 Block diagram of r.f. power sensor 1
2 Simplified diagram of amplifier 2

OVERALL CIRCUIT DESCRIPTION - see Fig. 1

1. The RF SENSOR gives a small d.c. output voltage when power is applied. This d.c. voltage is converted to an a.c. signal by the SIGNAL CHOPPER. The chopped signal is fed to the AMPLIFIER which is split into two parts, the first part being in the power sensor and the other in the power meter. The signal is then processed by the power meter to give a power reading. A Zener diode in the power sensor provides sensor type information for the power meter.

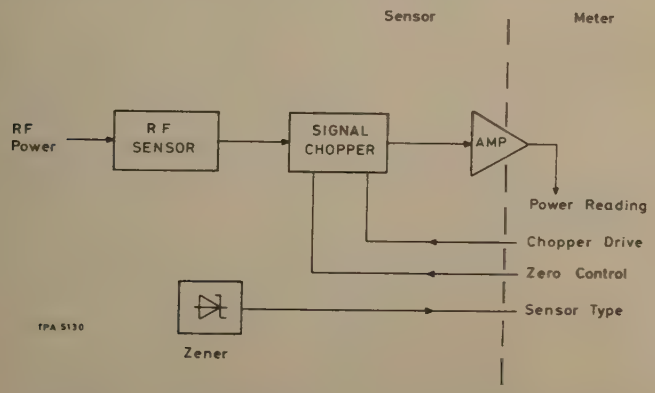

Fig. 1 Block diagram of r.f. power sensor

DETAILED DESCRIPTION *(Cct. diagram : Chap. 7, Fig. 1)*

RF sensor

2. The r.f. sensor consists of a low barrier Schottky diode, which gives an output voltage proportional to input r.f. power throughout its dynamic range.

Signal chopper

3. The signal chopper consists of two field-effect transistors which act as a sampling gate. The sampling rate is controlled by a 925 Hz square wave signal from the power meter. The output of the signal chopper is a 925 Hz square wave with amplitude proportional to the r.f. input power.

4. A zero control signal from the power meter is introduced at the input of the signal chopper. This allows the power meter to cancel any residual output that occurs with no r.f. power applied.

Amplifier

5. The amplifier is split between the power sensor and the power meter. A simplified circuit is shown in Fig. 2.

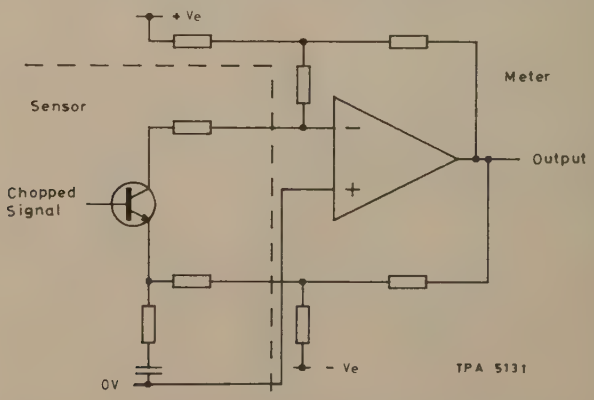

Fig. 2 Simplified circuit of amplifier

6. The amplifier has a gain of approximately 2000 and a band-pass characteristic centred at the sampling rate of 925 Hz. For a full description of the amplifier refer to the 6950 or 6960 Service Manuals.

7. A Zener diode is mounted in the sensor to provide head select information for the power meters. For 6920 type sensor a 2.7 V diode is used.

Chapter 5

MAINTENANCE

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1 Test equipment
2 Precautions
4 Initial testing
5 Access
6 Fault finding
8 Testing the r.f. assembly
12 Replacement of r.f. assemblies
12 Dismantling
15 Reassembly
18 Sensor zero value
19 Sensor zero adjustment

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1 Access and layout diagram 4

TEST EQUIPMENT

1.

Instrument	*Property*
6950 or 6960 Power Meter (with sensor cable)	
Digital voltmeter	Resolution : 1 mV.
Power supply	Capable of producing ±5 V d.c.
10 kΩ resistor	
Oscilloscope	Bandwidth : >20 kHz. Sensitivity : Better than 50 mV/div.

PRECAUTIONS

2. To avoid possible damage to the sensor:-

(1) Take care when leads are being attached to or detached from the pins of the r.f. assembly.

(2) Do not connect voltages across pins not mentioned specifically in this chapter.

3. Note also that the high sensitivity of this sensor is such that, unless the r.f. connector is properly terminated, stray radiation could be detected and displayed on the power meter.

INITIAL TESTING

4. Connect the sensor to a known working power meter type 6960 or 6950 using a known working sensor cable. After allowing time for thermal stabilization, zero and calibrate the sensor as described in Chap. 3. Should either fail proceed as follows.

ACCESS - see Fig. 1

5. Remove the sensor cable from the 12 pin connector on the sensor. Remove the rear plate screws SC1 and SC2. Remove the rear plate and slide the casing from the sensor.

FAULT FINDING

6. Reconnect the cable between the sensor and the power meter. Using an oscilloscope check that the two 925 Hz 0 V to -5 V square wave chopper drive signals are present on pin holders PH5 and PH6 with respect to chassis.

7. Connect the sensor directly to the POWER REFERENCE output of the power meter. Switch the power ref. on. Using the oscilloscope carefully measure the voltage waveform between pin holder PH2 and chassis. This should be a 925 Hz square wave of magnitude approx. -200 mV. If not the r.f. assembly appears to be at fault. This can be checked by following the procedures in paras. 8, 9, 10 and 11.

TESTING THE RF ASSEMBLY

8. Remove screws SC4, SC5 and SC6. Carefully pull the p.c.b. section away from the r.f. assembly. Connect the r.f. assembly directly to the 50 MHz, 0 dBm POWER REFERENCE output.

9. Using a d.c. power supply, apply -5 V, via a 10 kΩ resistor to pin P6 with the r.f. assembly chassis as ground. Connect pin P5 to the chassis. Carefully attach a lead from the -ve terminal of the DVM to pin P3 and a lead from the +ve terminal of the DVM to pin P1. Switch the POWER REF. on and check that the reading is greater than -200 mV. Reduce the d.c. supply to 0 V. The DVM reading should reduce to less than -60 mV.

10. Switch the POWER REF off. Again using the d.c. power supply, apply -5 V via the 10 kΩ resistor to pin P5 with the r.f. assembly chassis as ground. Connect pin P6 to chassis. Carefully attach a lead from the -ve terminal of the DVM to pin P3 and a lead from the +ve terminal of the DVM to pin P2. Switch the POWER REF. on and check that the reading is greater than -200 mV.

11. If both para. 9 and para. 10 give correct results then the r.f. assembly is functioning.

REPLACEMENT OF RF ASSEMBLIES

Dismantling - see Fig. 1

12. Remove the rear plate screws SC1 and SC2. Remove the rear plate and slide the casing from the sensor.

13. Remove screws SC4, SC5 and SC6. Carefully pull the r.f. assembly from the p.c.b. section.

14. To detach the p.c.b. and 12 pin connector from their retainer remove screws SC7, SC8, SC9 and SC10, and SC11 and SC12.

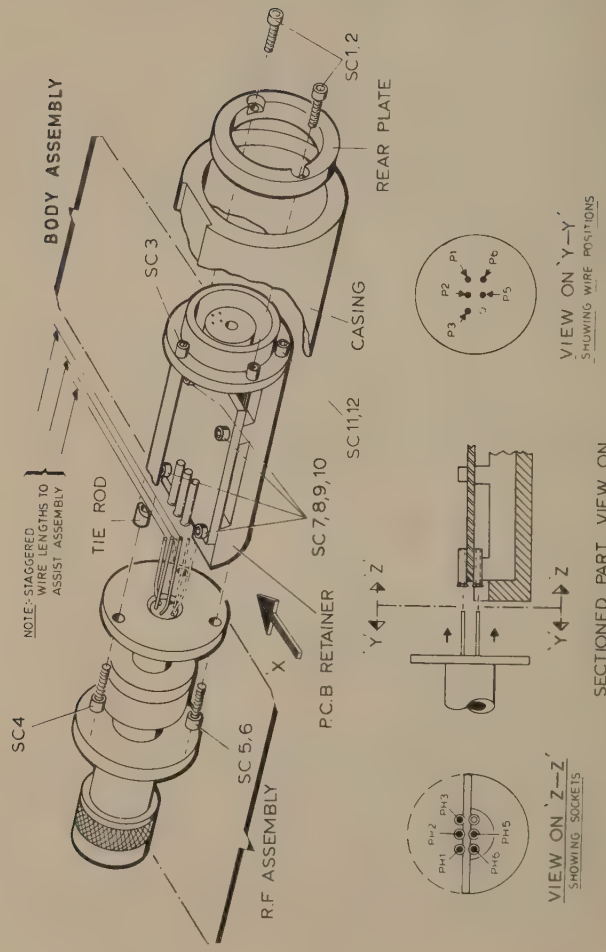

Fig. 1 Access and layout diagram

Reassembly - see Fig. 1

15. Fix the p.c.b. and 12 pin connector to their retainer by replacing screws SC7 to SC12. If the tie bar has been removed this should now be replaced by inserting SC3.

16. Insert the six pins from the r.f. assembly into the pin holders. The correct orientation is achieved in two ways:-

(1) The longest pair of r.f. assembly pins P3 and P4 must fit into pin holders PH3 and PH4 as in the diagram.

(2) When bringing the r.f. assembly and p.c.b. section together the tapped holes in the retainer and tie-rod must correspond with the holes in the r.f. assembly flange. When the six pins have been carefully inserted, secure screws SC4, SC5 and SC6.

17. Connect the partly assembled sensor to a power meter and check that it is functioning correctly as described in para. 4.

Sensor zero value

18. This is the residual output of the sensor when the zero control signal from the power meter is set to its central value and the r.f. input is zero. It is very rare that any adjustment is necessary but the value should be checked when a sensor is reassembled. With the sensor casing and rear plate removed as in para. 17, connect the sensor via a test cable to the power meter and detach it from the POWER REFERENCE output.

(a) Using a 6960 Power Meter:-

Put the meter into test mode by holding down any key and pressing RESET until the display reads TEST. Connect the LEVELLING OUTPUT on the back of the 6960 to a DVM. Press key [.] (decimal point) to set the power meter gain to max. Press key [8] to centre the zero offset. The zero value of the sensor, as displayed on the DVM should be in the range ±200 mV; if not, see para. 19.

(b) Using a 6950 Power Meter:-

Connect RECORDER OUTPUT on the back of the 6950 to a DVM. Set the range, using the scale disc appropriate to 6920, to -40 dBm. Set the GAIN adjustment fully clockwise. Set the ZERO adjustment fully anti-clockwise and note the DVM reading. Set the ZERO adjustment fully clockwise and note the DVM reading (note that one reading will be -ve and the other +ve). The arithmetic mean of these two readings should be within ±200 mV; if not see para. 19.

Sensor zero adjustment

19. Located on the sensor p.c.b. are a number of insulated wires, the wires relevant to the zero adjustment being

(i) Two chopper drive wires - one grey, one white.

(ii) Zero wire - purple.

It is through the correct positioning of these wires that the zero values given in para. 18 can be achieved.

20. As an indication of likely effects, bringing the purple wire close to the grey wire should make the zero value more positive, while moving the purple wire close to the white wire should make the zero value more negative.

21. Fit the casing and rear plate. Fit the rear plate screws SC1 and SC2.

Chapter 6

REPLACEABLE PARTS

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1 Abbreviations
2 Component values
4 Ordering
5 Components

ABBREVIATIONS

1. The components are listed in alphanumerical order of the complete circuit reference using abbreviations from the following list :

C	:	capacitor
Carb	:	carbon
Cer	:	ceramic
D	:	semiconductor diode
Elec	:	electrolytic
FS	:	fuse
IC	:	integrated circuit (package)
L	:	inductor
LP	:	lamp
Max	:	maximum
ME	:	meter
Met	:	metal
Mic	:	mica
Min	:	minimum
Ox	:	oxide
Pl	:	plug
Plas	:	plastic
R	:	resistor
S	:	switch
SK	:	socket
T	:	transformer
Tant	:	tantalum

TP	:	terminal
TR	:	transistor
Var	:	variable
W	:	watts at 70°C
WW	:	wirewound
†	:	value selected during test; nominal value listed
Ø	:	feedthrough component
	:	static sensitive component

COMPONENT VALUES

2. One or more of the components fitted in this instrument may differ from those listed in this chapter for any of the following reasons :

(a) Components indicated by a † have their values selected during test to achieve particular performance limits.

(b) Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the instrument is maintained.

(c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

3. When their is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the instrument.

ORDERING

4. When ordering replacements, address the order to the Technical Services Department of our Microwave Products Division (address on rear cover) or nearest agent and specify the following for each component required :

(1) Type and serial number of equipment.
(2) Circuit reference.
(3) Description.
(4) Part number.

COMPONENTS

Circuit ref.	*Description*	*Manufactuere/ Part No.*
	Power sensor, complete assy.	6920-001
	N type r.f. assy. replacement kit	6920-040
	Body assy. (incl. amplifier p.c.b assy. and SK1)	6920-003
	Tie rod	6920-011
	Casing	6920-010
	Rear plate	6910-019
	Amplifier p.c.b. assy.	6920-006
C3	Tant 1µF 20% 35V	26486-209F
C4	Tant 4.7µF 20% 6.3V	Sprague 499D
C5	Plas 0.1µF 20% 100V	ITT 8111MZ5U
C6	Tant 10µF 20% 6.3V	Sprague 499D
C7	Cer 0.047µF 10% 50V	26343-560M
C9	Tant 0.22µF 20% 35V	26486-205Y
C14	Chip 100pF 10% 100V	STC 0805FX7R
C15	Chip 100pF 10% 100V	STC 0805FX7R
D2	Zener BZX79C2V7	Motorola
R1	MD 30kΩ 2% 1/8W	Corning NK3
R2	MF 330Ω 2% 1/8W	Corning NK3
R3	MF 2kΩ 2% 1/8W	Corning NK3
R4	MF 10kΩ 2% 1/8W	Corning NK3
R5	MF 47Ω 2% 1/8W	Corning NK3
R6	MF 68Ω 2% 1/8W	Corning NK3
TR1	BC414	Motorola
SK1	Connector assy. (including C10 to C13, C16 & C17)	6910-052

Chapter 7

CIRCUIT DIAGRAM

CONTENTS

Para.
1 Component values

Fig. Page
1a Component layout 2
1 Circuit diagram 3/4

Component values

1. The letter in the component value code replaces the decimal point and indicates the multiplier and unit as follows:-

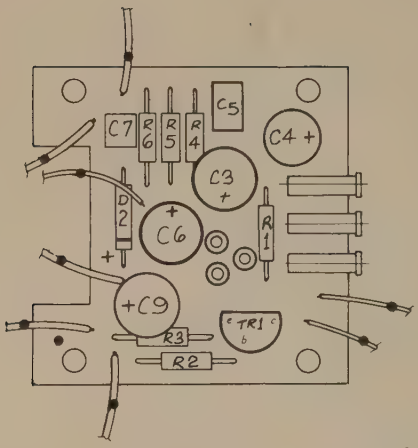
Resistors : Code letter R = ohms, k = kilohms (10^3),
M = megohms (10^6).

Capacitors : Code letter m = millifarads (10^{-3}),
μ = microfarads (10^{-6}),
n = nanofarads (10^{-9}),
p = picofarads (10^{-12}).

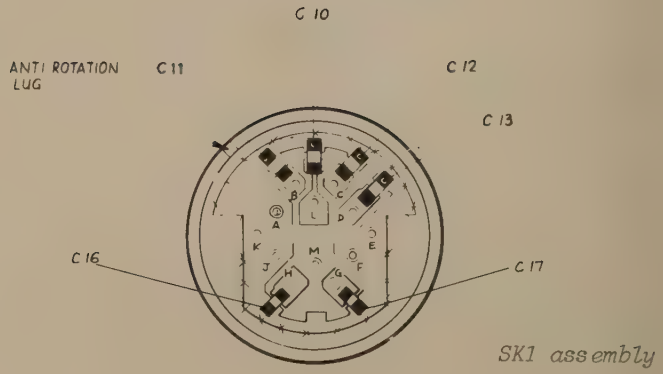
Inductors : Code letter H = henrys, m = millihenrys (10^{-3}),
μ = microhenrys (10^{-6}),
n = nanohenrys (10^{-9}).

* SIC : value selected during test, nominal value shown.

2. Components are marked normally with two, three or four figures according to the accuracy limit ±10%, ±1% or ±0.1%. Because a value 4m7 could be interpreted as 4.7 milliohms, millifarads or millihenrys, each value on circuit diagrams is placed near to its related symbol.



Amplifier p.c.b.



SK1 assembly

Fig. 1a Component layout

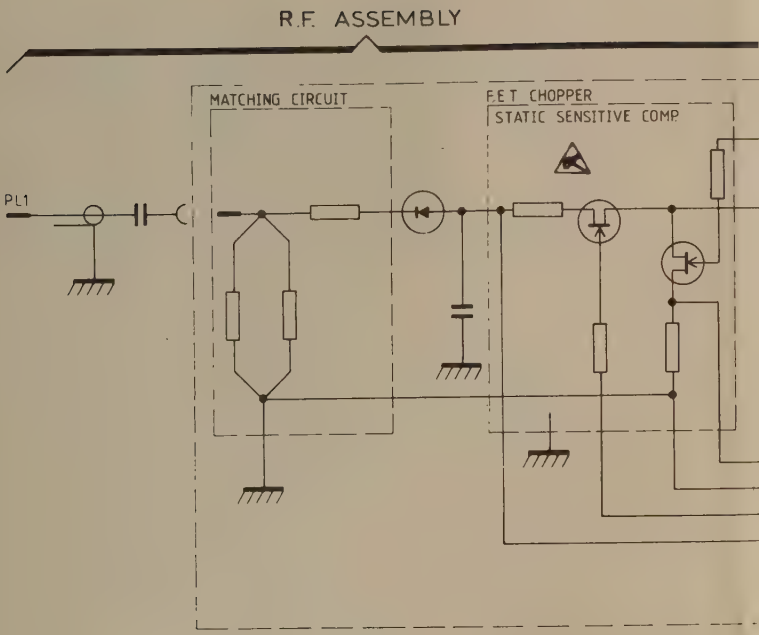
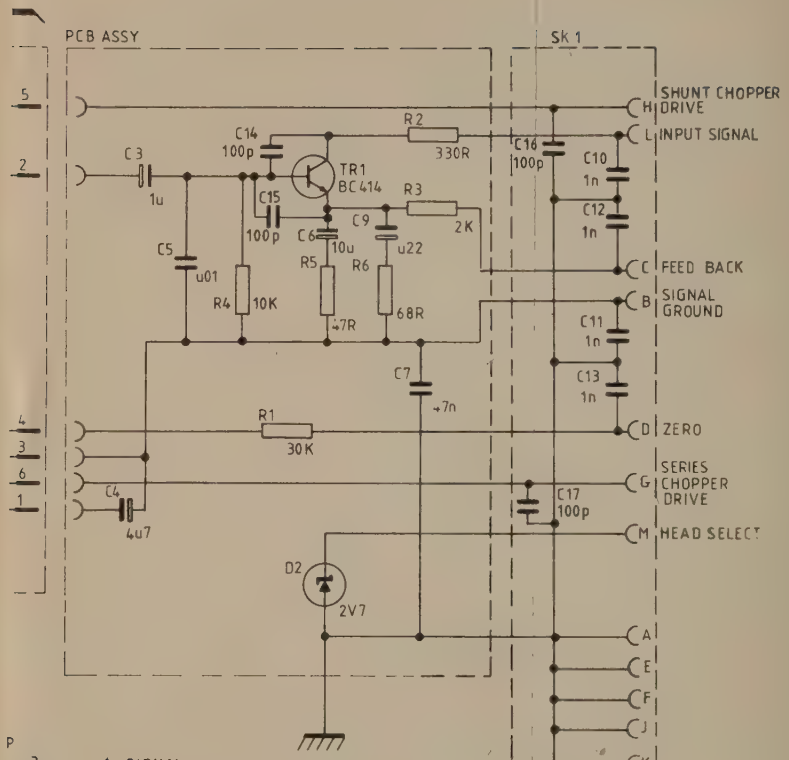


Fig. 1 Circuit diag



P

1 SIGNAL
2 SIGNAL OUT
3 SIGNAL GROUND
4 ZERO
5 SHUNT CHOPPER DRIVE
6 SERIES CHOPPER DRIVE

OF PCB

NS PCB ASSEMBLY TO RF ASSEMBLY

ram of 6920 RF Power Sensor

6920

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